

Perceptions of the Radiation Disaster from H-bomb Testing: Subsistence Economy, Knowledge and Network among the People of Rongelap in the Marshall Islands

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Abstract This paper considers the various perceptions of victims of radiation and the suffering they experience from the radiation disaster. Many studies have been conducted on the adverse impacts of radiation. However, the discomfort and anxieties experienced by people were often ignored or dismissed as anecdotal evidence or emotionalism with no policy relevance. In this paper, findings are described from long-term work with the Rongelap community documenting the impact of radiation exposure from US nuclear testing as measured by changes in behavior and language. This paper shows that ecosystem changes from H-bomb radiation rendered traditional forms of knowledge about the natural environment meaningless; this is not to be confused with a loss of explicit knowledge, but it means that the knowledge is no longer applicable to the current situation. 'The people of Rongelap, Rongerik, and Ailinginae, like other Marshallese, had a keen understanding of local environmental conditions, resources, and ecosystemic dynamics. Ecosystem knowledge was essential to survival. Atoll resources provided water, food building materials, tools, transportation, medicine, toys, and ceremonial items.' In other words, nuclear testing resulted in the loss of some kinds of cultural knowledge. This is important to understand, because subsistence societies require more than uncontaminated natural resources to thrive. They also require knowledge of the natural environment. Simply transplanting a living culture to another location of similar size and geographic position does not work.

Keywords The Marshall Islands, Atomic Bomb Testing, Radiation Perception, Network, Life Style, Knowledge

1. Introduction

This paper considers the various perceptions of victims

of radiation and the suffering they experience from the radiation disaster. Many studies have been conducted on the adverse impacts of radiation. However, the discomfort and anxieties experienced by people have often been ignored or dismissed as anecdotal evidence -- emotionalism with no policy relevance. In this paper, I describe findings from long-term work with the Rongelap community documenting the impact of radiation exposure from US nuclear testing as measured by changes in behavior and language.

The nuclear testing caused serious radioactivity pollution to Rongelap and the residents suffered from acute radioactive symptoms. People of Rongelap settled on Mejjatto Islet in Kwajalein Atoll as a community center for evacuation after having been relocated four times. The Rongelap Resettlement Project, which aimed at having all residents on Mejjatto Islet to go back to their home atoll, started in 1998 and finished the decontamination of the residential area. The radiation level fell below the safety reference value, and houses and infrastructure were constructed for the residents. However, even after twenty years from the initiation of this project, none of the evacuees on the refuge island have taken up permanent residence there.

Most of them say they want to go back to Rongelap. However, the most they actually do is to go there for periods of six months to three years to carry out activities such as pig farming, pearl culture and tourism.

How do people become aware of the radiation risk? Many of the people in Fukushima and some in Chernobyl have Geiger counters to measure the radiation in the air. In the Marshall Islands, however, no one has a Geiger counter. Nor have I seen any electric bulletin boards to show the radiation level in the air there. People have no choice but to try to judge the risk through perception and experience in everyday life, without any form of scientific measuring.

So, I focus my narrative on livelihood, its basis, and the thought that guides it, to understand the perceptions people

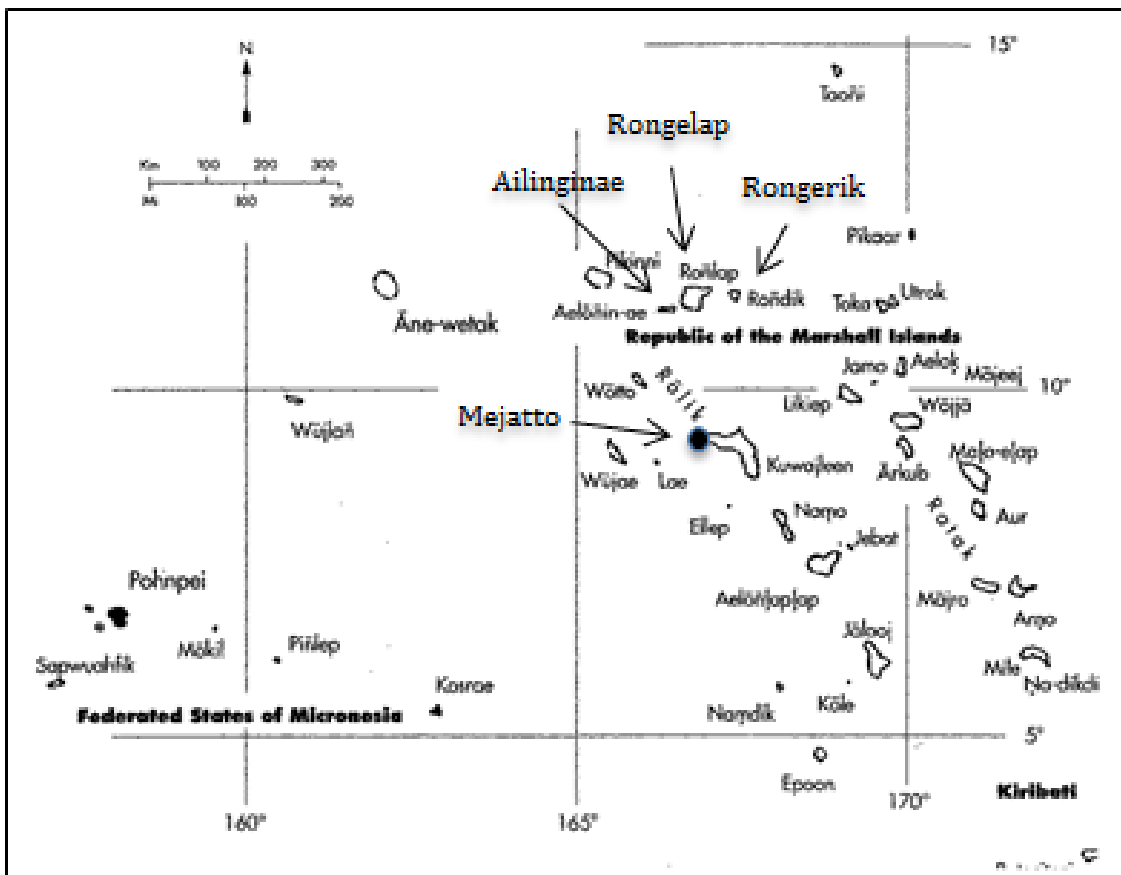
have of radiation impacts and risks. This paper examines their perceptions of radiation risks and impacts from the point of view of everyday life and of livelihood. Torigoe calls knowledge accumulated historically by people living in specific regional environments "everyday knowledge", and knowledge such as modern technology "scientific knowledge" [1]. Radiation effects, in particular, tend to be analyzed and evaluated by radiological experts based on measured values against safety standard values. When the officially published figures are less than the radiation safety standard, some people feel relieved, some people re-measure for themselves, and some people doubt the data and make other evaluations. I will examine people's perceptions of radiation through their "everyday knowledge."

In this paper, it is argued that the perceptions of people who are forced to live in an area affected by radiation are different from scientific perspectives achieved by

measurement and analyzing. Some scientists try to evaluate the claims people make through statistical analysis (Otaki *et al.*) and the science of radiology (Yamauchi *et al.*). This approach cannot examine the experience and the perceptions of radiation of the various different people within society, and therefore there is a whole range of impacts of the radiation that it does not consider. For instance, even though the radiation level of a particular local food is within a safe level, some avoid it, and even though the government says that a particular place is safe to live, some continue to keep away from their home there." In this paper, I focus on the narrative of ordinary people's perceptions of the effect of radiation or nuclear testing.

I will examine the thermonuclear bomb test disaster from an anthropological perspective that aims to show their disaster perceptions from the point of view of their livelihood and their everyday life.

2. Geological and Historical Setting



Laurence Marshall CARUCCI, *Nuclear Nativity: Rituals of Renewal and Empowerment in the Marshall Islands*, Northern Illinois University Press, 1997, p5. (Author revision)

The Map of the Republic of the Marshall Islands

The Republic of the Marshall Islands is composed of twenty-nine coral atolls and five coral islands in the Pacific Ocean (see Marshall Islands map), midway between Hawaii and Australia, with a total land area of 181 square kilometers (70 square miles). The population is 53,158 [2]. Since the end of the 19th century, the area has been governed by Germany, Japan, and the United States.

In this paper “Rongelap” refers to Rongelap, Rongrik and Ailinginae atolls, which together make up a unified living space. The whole land area is 12.43 square kilometers. The area is located in the northernmost part of the Marshall Islands. The people who hold land rights on these three atolls call themselves the people of Rongelap (*ri-Ronlap*). There, the variety of plants is limited due to poor precipitation; coconuts (*ni*), pandanus (*bob*) and arrowroot (*mokmok*) are the main flora in the area.

The United States ruled the Marshall Islands as a Trust Territory of the United Nations from 1947 until 1986. From 1946 it conducted atomic and thermonuclear bomb testing and from 1958 missile experiments there. In 1986, the Marshall Islands gained independence. The United States maintains a military base there even after the country became independent, and it gives economic aid to the Marshall Islands as well as nuclear disaster compensation, which is regulated in the international treaty, the Free Association Compact.

The Republic of the Marshall Islands suffered greatly from radioactivity by 67 nuclear tests conducted by the U.S. from 1946 to 1958.

The 82 residents of the Rongelap Atoll were most directly impacted by the thermonuclear weapon test, code named “Bravo”, which was detonated on March 1, 1954, the biggest test ever, and yielded one thousand times greater magnitude than that of the Hiroshima bomb, “Little Boy.” Soon after the Bravo explosion, Rongelap’s residents suffered from acute radioactive symptoms and were rescued three days later. Some of them developed late radiation sickness, and they have all been relocated. Since then, they have been moved several times. In 1985, they were moved to the Mejjatto Islet in the Kwajalein Atoll and have lived there since. The land area of Mejjatto Islet is only 0.23 square kilometers, which is one fifty fourth of the area of Rongelap, with a population of 207 as of August 2013.

3. The Culture Nurtured on Atolls

Since the average altitudes of the coral atolls and islands are around two meters, there are no mountains or rivers. Rain water penetrates into the coral layer and forms a “Freshwater Lens (Ghyben-Herzberg lens)” on the saltwater layer that has penetrated in from ocean. This provides fresh water for plants and for people, who access it by digging wells. On land, with fewer nutrients, the main plants are coconuts, pandanus and breadfruit (*ma*). On the other hand, marine resources are relatively rich. In

particular, shallow lagoons surrounded by small islets and coral reefs surrounding coral islands are abundant in fish and shellfish. Lagoons enable fishing activities on stormy days, with the islet becoming a natural breakwater for the lagoon.

These low atolls and islands are vulnerable to disasters, which easily destroy the freshwater lens layer. The saltwater and rainwater that penetrate into the coral layer separate into two layers due to the difference in weight of saltwater and freshwater. During droughts, the freshwater lens layer shrinks and becomes salinated, and it can also be damaged by seawater coming over the land during low pressures or typhoons and penetrating into the coral layer from the surface.

Atolls are formed of several small islands, of which even some relatively small islets (one or more) are inhabited. Many other small islets are uninhabited, but are used for gathering food and living materials (wood and coral fragments). Society in the Marshall Islands is matrilineal, with the right to use land for such things as building houses, gathering resources, etc., being passed on through the maternal line. Kin members of the matrilineal clans come together for activities such as taking care of fields and orchards, harvesting, fishing, church participation, rituals, meals, lending and borrowing goods, and helping relatives. Nowadays, the production of copra, the raw material for coconut oil and an export product of the Marshall Islands, brings residents cash income by which they purchase imported goods and food. Both the subsistence economy and the production of export goods are based on the resources of the atolls and islands.

Those resources that are used as preserved foods are seldom used for personal consumption, but are rather distributed to kin members and sometimes friends living away from the home area due to marriage, adoption, staying with relatives or friends, etc. Relatives visit the family and deepen friendship by meeting at first-birthday parties (*kemen*), weddings, funerals, Christmas, summer holidays and so on. In this way, the people of the Marshall Islands have built and maintained networks among kin members outside the areas where they live.

Family networks constructed and maintained have also played a role as a safety net in the event of disaster. Even when disasters such as typhoons and prolonged droughts make life impossible on the atolls and islands, these disasters affect only some areas and not the whole of the Marshall Islands, due to the highly dispersed geography of the islands. This makes it possible to receive migration from affected islands and offer support on the unaffected islands in the event of disaster. The highly dispersed nature of the islands can be a disadvantage in terms of maintaining frequent face-to-face human relationships, but it is an advantage in protecting people from disasters.

Living on coral atolls and islands require local knowledge. Knowledge regarding tree-planting, medicinal herbs, methods of preserving foods, fishing methods, etc. is

forms of general knowledge in the Marshall Islands. Knowledges of such things as ocean currents, the niches of plants and shells, the distribution of lagoon coral, the kinds and the distribution of poisonous fish, the stars, the weather, etc., are forms of knowledge specific to each atoll and island, and differ for each area.

Local knowledge is inherited from one generation to the next. It is passed on only to those who can be trusted with it. Local knowledge for sailing by canoe (navigation skills such as knowledge of ocean currents, weather, waveforms, the stars, etc.), for example, is exclusive knowledge passed on only to certain men in the living space. This kind of knowledge, rather than being acquired through education, is passed on to individuals through participation and experience. Therefore, when the opportunity to use this knowledge is lost, knowledge is not passed on.

Remote islands in the Marshall Islands still use the general knowledge and natural knowledge of the natural environment inherited from their predecessors in the areas where they live and in their relationships beyond that area. Atolls are fragile and vulnerable, and the people of the Marshall Islands have acquired the skills to survive and to manage these vulnerable atolls through knowledge and through networks of people [3].

4. Rongelap's Experience of the Bomb Test

On March 1, 1954, the United States detonated the Bravo test on Bikini Atoll, located 210 kilometers from Rongelap Atoll where 82 residents lived. From around noon that day, radioactive ash started raining down on Rongelap Atoll. Land was contaminated by radioactive fallout and the residents and four babies still in the mother's wombs were exposed to radiation. Some people developed acute radiation sickness such as headaches, dizziness, and nausea. Three days later, they were evacuated to a U.S. military base in the Marshall Islands. They did not bring any belongings with them for this evacuation. One said she lost the memoir book in which her family genealogy was written. They spent three months on the military base, and were subsequently moved to Ejij Islet in Majuro Atoll after some of the original inhabitants of this atoll had been moved.

In 1957, the United States Atomic Energy Commission (AEC) recommended that people return to Rongelap Atoll. Two-hundred and fifty people, including those most exposed and also those who had not been exposed but who held land rights on Rongelap, went back to Rongelap Atoll, even though some were suspicious of its safety. The AEC recommended not eating food from the northern part of Rongelap Atoll, where the inhabitants traditionally had gathered food.

The people of Rongelap had serious medical problems. Almost all women had miscarriages and/or stillborn babies,

already while there were on Ejij Islet. After their return to Rongelap Atoll, some residents developed symptoms such as vomiting, reddening of the skin and numbness after eating local food. From 1964 on, people started to show symptoms of thyroid disorder, cancer and leukemia, which are considered to be the effects of radiation.

"While the U.S. government continued to assure the people of Rongelap that living on their atoll presented no threat to their health, it was evidently concerned about the ill effects of short-term exposure to its own workers. Consider the June 27, 1977, examination and analysis of a Peace Corps worker who spent eight months on Rongelap teaching elementary school (1975 -1976), three months on Majuro, and an additional nine months on Rongelap (1976-1977)" [4]. "Urine samples and measurements from the whole-body counter found the presence of cesium-137 in the American Peace Corps worker (measured body burden of 45.2)" [5].

The long-term effects of low radiation such as thyroid and other disorders are still largely unknown. Damage claims are still in the courts (Nuclear Claims Tribunals in the Marshall Islands) to this day.

In 1982 the United States Department of Energy (formerly AEC) published a report on the contamination levels of radiation in the northern Marshall Islands. This report indicated that the residents on Rongelap Atoll received 400mSv per year of internal exposure, which leads to a theoretical forecasting of death at the rate of 0.1 to 0.6 people in 233 people. This report indicated that the level of the radiation on Rongelap Atoll was the same as on Bikini Atoll [6]. In May 1985, the Rongelap people moved to Mejjatto Islets in Kwajalein Atoll.

After evacuation from Rongelap Atoll in 1985, the local government of Rongelap initiated the Rongelap Resettlement Project that aimed at having all residents on Mejjatto Islet go back to their home atoll. In 1996, the Government of the United States and the Rongelap Local Government reached an agreement regarding resettlement, the building of infrastructure, and the decontamination of Rongelap Atoll.

After the decontamination of the residential area, as of August 2013, the minimum infrastructure such as an air strip, a road, a church, a town hall, a power plant and a water supply have been constructed and some pig farming and pearl culture projects have been carried out. Around thirty Rongelap people live on Rongelap and work on one or another of these projects [7].

5. Loss of Subsistence Economy

In this section, I discuss the perceptions of the changes on the Rongelap Atoll affected by radiation between 1957 and 1985.

For twenty-eight years between the time when the people of Rongelap returned to their original homes in

1957 and when they evacuated Mejjatto Islet in 1985, they have mainly depended on the natural resources of Rongelap, except for C-rations for five years just after returning back to Rongelap and USDA (United States Department of Agriculture) food aid for some years of the 1970's due to typhoon disaster. It goes without saying that this food aid did not cover all their food necessities, and therefore they had no choice but to eat food from the land and ocean that might have been contaminated by radiation. The people lived on Rongelap Islet, which is the largest islet in Rongelap Atoll, cultivating and gathering food not only on Rongelap Islet but also on other islets in Rongelap Atoll, Ailinginae Atoll and Rongerik Atoll.

On some big islets in several atolls, people had planted food crops, mainly coconuts and pandanus. There were some taro potato and breadfruit (*ma*) also planted, but few due to limited precipitation. Coconut is used for food, fed for domestic animals, and for producing copra which was to be exported as a raw material of coconut oil. The people of Rongelap made a preserved food from pandanus called *jaankun*, a candy from coconut fruit, and preserved syrup from the sap of the coconut tree. *Jaankun* production is rare in the southern area of the Marshall Islands where it is not necessary because of the presence of several kinds of fruits and taro potato. Traditionally, *jaankun* was one of the most important traditional foods, as much of it was presented to the chiefs in earlier times [8].

On almost all islets, they raised chickens, pigs and turkeys, cultivated arrowroot, hunted wildlife such as wild birds, and gathered their eggs, turtle eggs, coconut crabs and crabs. They stayed one day, several days or two weeks in a particular area, depending on the kind of activity: one day for fishing, several days for making arrowroot powder or drying fish from several kinds of fish, two weeks for copra producing.

There are never many land resources, whereas, the marine resources are abundant. Rongelap has marine diversity, being blessed with fish, shellfish, octopus, shrimp, turtles in its lagoon, and shark migratory fish in the open sea [9].

"It's easy to get a bird. When you turn a flashlight on a bird sleeping in a tree in the night, it's surprised by the brightness and falls down. Then you take it. Eggs are also easy to gather. In Eneaitok Islet, wild birds and their eggs were all over the islet. You put as many eggs as you wanted in your bag and took them home. And you boiled them and ate it. That's it! We could live well without money. For free. We did not need money even in the Christmas season. I want to go back to Rongelap 1000 percent." (Male, 50's, December 27, 2016)

In the Marshall Islands, in principle, land is inherited in the matrilineal line (*kapijukunen*), but it can also be passed on through the male line (*lamolen*, for example, when there are no daughters). The same happens on Rongelap. Actually, the people of Rongelap used to use almost all islets to gather, cultivate and produce foods. "Rongelap is

one family (*Ronlap juon wot bamili*)" is the expression which the people of Rongelap use, meaning that they are related to each other and share natural resources in Rongelap. Radioactive contamination brought serious harm to this sustainable life activity.

Some of the people say they have seen two or three deformed coconut trees; some claim to have seen a hundred or more.

I saw two deformed coconut trees with two trunks. These frightened me. Nobody talked about deformed coconut trees when I lived on Rongelap. I saw fish with lumps while fishing. Nobody told me of the danger of food in Rongelap. It was after we moved to Mejjatto Islet that we heard talk of the danger of radiation. (Male, 50's, Born on Rongelap, interviewed in 2016)

Everyone ate all kinds of food available in Rongelap at first. That's because Americans did not say that it was dangerous at first. There were plenty of coconuts and plenty of fish...everyone was excited about food. Coconut crab in particular was considered excellent to eat. But a while later, their mouths became swollen; and spots appeared on the skin around the mouth. Later, AEC (the US Atomic Energy Commission) prohibited eating them. After that, we began to suspect that the food was contaminated by radiation. And we became afraid of eating food in Rongelap. My daughter was often coughing when she was a child. Radioactivity might have caused it. (Female, 60's, Born on Rongelap, interviewed in 2016)

When I heard this story, I suspected that it might have been calibrated to maximize compensation from the United States. However, biological research has shown the effects of the H-bomb testing, and the resulting radiation can alter the natural environment and change edible fish into poisonous fish [10]. Eating fish became toxic to people. The people of Rongelap knew which fish were edible, and have handed down this knowledge through generations. But it is possible that people were getting mildly poisoned by eating toxic fish that had once been edible.

Despite suspicions regarding the safety of the food, many people continued to eat local food.

I recall one incident when I was ten or so. One day, I could not stand that we cannot eat coconut crab. I really wanted to eat coconut crab. So, I rushed into a coconut orchard by myself and caught one, cooked it and ate it. Adults used to eat it and say that they could eat it because they were old enough to. They watched over us children all the time to make sure we did not eat coconut crab. They said that children could not eat arrowroot and coconut crab because they are so contaminated by radiation. (Male, 60's, Born on Rongelap, interviewed in 2016)

There were people who were not in Rongelap at the time of test. Nor were the parents there. But they have had to have thyroid operations. Some of them have had children stillborn. One person's child could not walk or even think. How could something like this happen? The grandson of one person exposed to radiation at the time of the test had a deformed baby. Two couples have each had babies whose body length was abnormally short. It is incredible that an unexposed spouse had a deformed child. I haven't seen a child like that. (Female, 60's, Born on Rongelap, interviewed in 2016)

Almost all people who lived on Rongelap for any time during this period have seen deformed fish and coconuts and have noticed that arrowroots have become smaller and their number is in decline. Many experienced numbness, redness, and nausea after eating fish, coconut crab or arrowroot. In spite of this, some could not stand life without these foods. The lives of peoples depending on local food were affected quite substantially.

6. Can Drowning Be Recognized as Damage from the H-bomb Testing?

One night after dinner in August 1998 when I stayed on Mejjatto for research, a local council member of Rongelap Assembly and I sat down on a coral yard looking over the dark blue gray lagoon. He told me the story of a man drowning in the lagoon when the people of Rongelap evacuated to Mejjatto Islet. The story is as follows:

Before the whole community of Rongelap moved here, an advance party made up of some Rongelap young men came to prepare for settlement. They were building an assembly house for children and women to sleep. It was to be used as a school in the daytime and a church on Sundays. A big supply ship was anchored at a point one kilometer from the shore where they were working. At that time, the sea was quite rough and the current was running fast. We could not send our small boat to the supply ship to get construction material and food. We waited one day, but the sea was still too rough. A young man said "OK. I will swim." One man from Ebadon happened to be here to help us and he shouted out to him. "Don't go. It is dangerous here according to our traditional story!" But the young man did not listen to him. He swam out into lagoon, but drowned and never reached the supply ship. We were looking for him for days. At last I found him under sea. His long hair was moving slowly in the water and caught on the coral. (Male, 40's, Born on Rongelap, interviewed in 1998)

The first time I heard this story, I thought of it as a misfortune or accident due to bad weather. However, there is another aspect to this story when considered from the

point of view of indigenous knowledge. Not a few people complained about the lagoon and ocean. One man showed me scars throughout his body that came from being attacked by a shark; one man was too afraid to fish around Mejjatto because he was ignorant of the environment of this area. One woman told me her husband drowned during fishing and she complained to the Nuclear Claims Tribunal, which is for nuclear victims' compensation, that her husband died due to the evacuation from Rongelap to Mejjatto Islet where he was not accustomed to fishing. She told me she did not know whether or not the Nuclear Claim Tribunal would accept her claim and she just wanted to try it. All said that this accident would not have happened on Rongelap.

Concerning the young man in the advance party who drowned in Mejjatto, the people of Ebadon had told him that it was a dangerous area, but the young man insisted that he could reach the ship. Some witnesses told me that he thought he would be able to reach the ship when he saw the current. People came to realize that first anchorage site was not suitable for big ships, and the ship was moved to an appropriate location.

Mejjatto Islet was the evacuation center. It is an uninhabited island that belongs to the people of Ebadon Islet. The people of Rongelap knew only its name and did not know what kind of place Mejjatto was before the evacuation. Some thought that Mejjatto was an islet; others thought that it was a place name on Ebadon Islet. The young man in the advance party did not have information about the dangers in the area as part of his traditional knowledge. None of the people of Rongelap knew the currents around Mejjatto Islet. Accidents such as drowning and shark attacks, and being afraid of the lagoon are not simply accidents that arise from the conditions or circumstances, but also result from the fact that people do not have knowledge of the currents as part of their own indigenous knowledge.

Their ignorance of the tidal flow and of the natural environment of the coral also brought other problems. Firstly, for the first time in their lives, they did not know where to catch fish or shellfish. The people of the Rongelap caught few fish.

Secondly, with regard to poisonous fish, some species of Marshall Islands fish can become ciguatera toxic under specific natural conditions. Therefore, the distribution of ciguatera poisonous fish varies according to habitat. Sometimes, the edible species of fish in Rongelap can be toxic in Mejjatto Islet.

The people of the Ebadon Islet taught them about specific toxic fish. But fish which the Ebadon people said were safe sometimes could be toxic. For instance, "*Jome*" were edible in Rongelap. In Mejjatto almost all *Jome* are edible, but about one in a hundred *Jome* is toxic and causes some degree of illness. This does not depend on the place in which the fish was caught. So, some people occasionally suffered from symptoms of poisoning after

eating *Jome*. The Mejatto people asked the people of Ebadon the reason for this. They answered. “*Jome* is like that in Mejatto. Sometimes it can happen to be poisonous.” There was a difference in the perceptions of the people of the Rongelap and the people of Ebadon regarding what level of toxicity constitutes and acceptable risk.

The people of Rongelap were accustomed to using several methods for checking the toxicity of fish. They would put a 10 cents coin (a dime) on the lips of the fish, and if it was toxic, the color of the coin would turn brown. This knowledge from Rongelap Atoll was not applicable on Mejatto Islet. The gradually learned which fish in Mejatto were toxic and how toxic they were.

Knowledge about land is also crucial. There were very few of plants required for living such as coconut, pandanus and breadfruit, on the island on Mejatto Islet, which had been an uninhabited island. They could not make preserved food from fruits as they did in Rongelap. They had to clear the bush and search for seeds. It took more than ten years for tree planting, growth and harvest. The knowledge of how to make traditional preserved foods from fruit had been almost lost in the first fifteen years after evacuation.

Although they had gone to the trouble of raising fruit trees, some of these withered. They had not been able to identify appropriate places for planting the trees. There are some places where underground water (*aeboj lal*, Ghyben-Herzberg lens) can easily dry up or become mixed with salt water. Thus, in the unfamiliar environment of Mejatto it was difficult for them to select a suitable site. They might have known the underground situation in Rongelap Atoll; but they did not know it in Mejatto Islet. Recently, the death of trees happens frequently due to rising sea levels.

These bits of knowledge were inherited from their ancestors and modified little by little to adjust to current conditions. They had the knowledge when they lived on Rongelap, but they do not know the current conditions of Rongelap. They did not lose their indigenous knowledge, but their indigenous knowledge about Rongelap for supporting a subsistence economy lost its usefulness. Indigenous knowledge has tended to be ignored in calculating the harm that comes from the radiation disaster. However, the radiation disaster forces the victims to evacuate their home area where their indigenous knowledge is embedded and where the fundamental elements of their identity are rooted.

Knowledge is necessary for people to live on natural resources. There are two kinds of traditional knowledge. One is general knowledge such as the efficacy of medical herbs, how to make preserved foods, the usage of coconut trees and reefs. The other kind of knowledge, such as knowledge of where to get natural resources, the currents in the area, the underground water conditions and so on, is only applicable to the particular area. This kind of knowledge is effective in that area, but it is not when you move to a new location.

This latter kind of knowledge is what has been significantly affected by the radiation disaster, because the radiation disaster forced residents to relocate far away from their original homes, which brought the victims a sense of loss since they could not use their local knowledge anymore. People could use general knowledge at the place where the victims relocated, however they could not use the knowledge specific to the place. When people cannot use the land due to contamination, the knowledge of how to use that land loses its usefulness. In the following selection, I will give another example of how traditional knowledge has become inapplicable, and how this is a loss of cultural heritage.

7. Canoe Knowledge Lost – Loss of Network beyond Rongelap

People often talk about the loss of Rongelap’s navigation skills, including knowledge of the waves and stars. Erdland has pointed out, “Most of the experts are on navigation and the stars are distinguished persons [11]” in the society of the Marshall Islands. Navigation skills are crucial to the community.

There were a number of captains or navigators of canoes in the Rongelap community, but I have never seen a resident on Mejatto Islet sailing by canoe in the whole six times I have been there for fieldwork in the years between 1998 and 2013. They used motorboats to go to neighboring islets or to go fishing.

There were many captains in Rongelap. There was a school on Rongelap to teach navigation skills, such as knowledge of the stars and the wind. But we do not sail anymore. (Female, 50’s, Born on Rongelap, interviewed in 1999)

One navigator was excellent. He could direct crew members lying in a canoe without watching the ocean. I heard that he would suddenly wake up when the noise of the water hitting the side of the canoe changed. He would direct the crew to change course and then go to sleep again. (Female, 60’s, Born on Rongelap, interviewed in 2016)

The people of Rongelap are proud of their navigation skills in the Marshall Islands, because canoe voyaging is dangerous. Finch (1887, p.500) narrates an example of seven canoes that left Jaluit for Ebon in early August 1880. Having lost their way, they drifted to Mili, reaching it four weeks later. Twelve of the fifty Marshallese people died of starvation and exhaustion. On 25 September, after a two days sail from Mili, now nine Jaluit canoes, accompanied by eleven canoes from Mili, reached Jaluit. On 9 October a fleet of eighteen canoes left for Ebon again, reaching Kili two days later. A storm then sent the fleet off course. Tacking two and fro, searching for land, the remaining canoes eventually reached Namorik on 6 November. Four

canoes became separated in the days after the storm and all on board perished [12]. The Marshallese navigation knowledge is unique in the Oceania. In contrast to other islanders in Oceania who guide their canoes primarily by the stars and winds, the Marshallese guided their canoes primarily by the flow of swells and currents moving through the atolls composed of the myriad islets and islands. There they developed the wave-pattern navigation [13].

However, knowledge of canoeing in Rongelap has been fading since the Bravo hydrogen bomb test in 1954. Some Rongelap captains went back to Rongelap in 1957, but since all Bikini communities were evacuated due to the atomic bomb testing, they no longer had destinations to go to or use for their skills. According to Spennemann, traditionally, Rongelap had direct relationships with Rongrick, Whotho and Bikini. This is revealed by records of the spread of communicable diseases, records of the origins and destination of vessels arriving in and departing from different atolls in the Marshall Islands, and records regarding journeys of canoes adrift. [14]. Further, food in the northern part was contaminated by radiation and this also reduced the need for canoe travel. Knowledge that has lost its usefulness and serves no purpose tends to disappear.

The knowledge of the sea in particular is crucial. It is necessary for the Marshallese people when a natural disaster occurs [15]. Therefore, knowledge of sailing is something necessary to develop a day-to-day network that will be effective in times of natural disaster. Knowledge of the tide, the climate, the weather, the winds, the stars have accumulated independently on each atoll. Voyages relying on specific stars differ for every atoll. And this knowledge is not shared by all residents of each atoll but basically handed down from generation to generation from one person to one person. There were several navigators in Rongelap.

The relationship between aristocrats and ordinary people of neighboring atolls was important for a rescue system for disasters in the Marshall Islands. Tobin regards lineage (*bwij*) and klan (*jowi*) as the units of social security [16], in which the Marshallese people fulfill their obligations of “*jipan* (help)” [17]. It is through canoes that they related to each other and confirm that they are companions.

There are around thirty clans each of which consists of several lineages. When a woman moves to another atoll or island to marry a man, she comes to have children at the man's place and might increase her lineage members at the man's place. Such women are called “Flying Ladies (*kora mem nu nar*)” who relocate to another atoll. Flying ladies from another atoll or island can be found on many atolls or islands, such as Rongelap. There exist many flying ladies from Rongelap in Bikini, Lae and Ujae, which are close to Rongelap. When their original homes fall into a crisis, flying ladies are obliged to help.

My mother and father were born and bred on

Rongelap. They had land rights on Rongelap. I was adopted by relatives in Ujae. So, I was on Ujae at the time of the Bravo test. I moved to Ejij islet, where the people from Rongelap who had been exposed to radiation were relocated from the Kwajalein military base with that relative on a government boat. When a serious event such as illness or death of a family member occurs, or when there is serious damage from a natural disaster such as a typhoon, we always go. This is our custom. If you do not go back home, they say you are a senseless person. (Female, 60's, Born on Rongelap, interviewed in 1998)

The connection with family members on different atolls are maintained over the long term through participation in funerals, Christmases and first birthday parties. The housewife distributes the food among all those present and does not forget absent members of the family and intimate friends [18]. Also, ladies have the custom of taking care of clan members who live on other islands or atolls [19].

Drought and typhoon might cause serious damage to people's lives due to the fact that the atolls average only two meters above sea level. When a typhoon or other disaster occurs, people are expected to help their relatives and children [20]. Preparations in the Marshall Islands do not include the construction of breakwaters or evacuation areas on high land. Rather it involves the building of a network for restoration after disaster.

Since the people of Bikini had been evacuated in 1946, the people of Rongelap lost their life companions. The people of Bikini were related to the people of Rongelap by blood and marriage. Once the people of Rongelap had no further reason to go to Bikini, they have rapidly lost their navigation skills.

What this means is that they have lost their traditional culture, not as a result of their own failure to preserve it, but because of the change of circumstances that has come into their lives. Cultural loss will happen worldwide in the wake of globalization. People cannot preserve their cultural heritage on their own. As the above shows, it is the loss of life companions and networks that has resulted in the loss of navigation skills.

8. Bridging the Divide between Local Knowledge and Science Knowledge

The U.S. government paid compensation to the people of Rongelap for the damage from nuclear testing for 15 years from 1987 to 2002 without consideration for the loss of knowledge and of networks in the actual living conditions of the people. This has a connection the idea that ordinary citizens are not considered as having scientifically accurate knowledge [21].

However, Alvin Weinberg, director of the Oak Ridge National Laboratory in the U.S., has raised doubts about

the effectiveness of policy decisions made without considering public perceptions of the consequences of science and technology. He uses the term "Trans-Science [22]" to describe questions that can be raised by science but which it cannot answer, such as various questions related to nuclear power generation and genetic engineering technology. Based on this idea, from around the late 1980's, ordinary people have not been merely passive subjects to be educated about science but have become active subjects who evaluate science and technology in the context of the diversity of social life [23]. This has come about precisely because research has revealed that ordinary people understand the influence of science in a daily context in a way different than that orthodox modern science [24].

Despite these changes in the evaluation made of the general public in the trans-science field, the compensation for radiation damage in the Marshall Islands has not reflected the opinions and perceptions of the people who evaluate the effects of radiation in the context of their daily lives. Studies applying a scientific method to clarifying the perceptions and perspectives of ordinary people have been few, compared to studies that show estimates of the level of radiation and how they affect the human body and the natural environment.

Under these circumstances, what can the people of Rongelap do to improve their situation? People have experienced concrete and specific effects of radiation on their lives in the environment of the Marshall Islands. This experience is valuable data that cannot be reproduced in a laboratory, even by researchers with expertise in radiation science. Radiation scientists therefore need to be informed by people about the effects of radiation they have actually experienced. To that end, people may need a better knowledge of the differences between the effects of radiation as they are understood in radiation science and as they are understood in real life. To do this, people may need to learn more about the methodology of radiation science.

However, it is not realistic to expect the people of Rongelap to achieve this on their own, or even with the help of the Rongelap and the Marshall Islands government, given the financial limitations of the country. What would seem a conceivable approach at this time would be collaboration between international NPOs, including ICAN (The International Campaign to Abolish Nuclear Weapons), which received the 2017 Nobel Peace Prize, the UN Human Rights Council, which investigated the effects of radiation in the Marshall Islands, and groups of people from around the world who have been exposed to radiation. At this point, the Rongelap Government is expected to play a new role beyond the current measure of promoting the resettlement project and the industrial development of the Rongelap Atoll based on the environmental impact assessment showing the safety of Rongelap conducted by the US government [25]. Therefore, a new role for the Rongelap government would

be to cooperate with these international organizations for "creating a venue" to deliver the voices of the people of Rongelap who experienced effects of radiation in their community to the international community. Through these collaborations, the people of Rongelap should be able to fulfill the role of spelling out "the damage they experienced in words that can be understood by scientists."

9. Conclusions

This paper shows that ecosystem changes from H-bomb radiation have deprived traditional forms of knowledge about the natural environment of their usefulness; this is not to be confused with a loss of explicit knowledge, but it does mean the loss of knowledge as a cultural heritage. "The people of Rongelap, Rongerik, and Ailinginae, like other Marshallese, had a keen understanding of local environmental conditions, resources, and ecosystemic dynamics. Ecosystem knowledge was essential to survival. Atoll resources provided water, food, building materials, tools, transportation, medicine, toys, and ceremonial items." [26]. In other words, nuclear testing resulted in the loss of some kinds of cultural knowledge. This is important to understand, because subsistence societies require more than uncontaminated natural resources to thrive. They also require knowledge of the natural environment. It is not sufficient to transplant a living culture to another location of similar size and geographic position.

Johnston described traditional knowledge as follows:

In reviewing traditional patterns of resource access and use interviewees expressed keen frustration in their current ability to teach the younger generation the information and skills needed for survival on an isolated atoll. Knowledge that informants identified as being important to pass on to the next generation included information on survival and self-sufficiency, sustainability, storing and preserving resources, sharing of resources, medicine, legends or *bwebwenato* (telling story), navigation and strategies for coping with famine, drought, and other dangers [27].

In general, it is believed that societies lose their traditional knowledge of the natural environment when they shift to a lifestyle marked by personal security and urban efficiency. However, this looks at just one side of the issue. We must consider the effect of atomic bomb testing not only from the medical and radiological points of view, but also in terms of lost knowledge, and lost networks of knowledge. Such consideration is required to make policy going forward, and compensation for the past.

This study focused on the narrative of individuals exposed to radiation. People have lost not only land, food and health but also the knowledge and networks for

managing and supporting land, food and health. They have survived in their daily lives and emergency situations by utilizing knowledge of specific lands and through sharing resources produced in specific lands with relatives and friends. This is a different way to survive both in everyday life and in emergency situations than is found in developed countries.

For example, most people living in developed countries get information on weather by paying money to subscribe to newspapers and by watching television. However, the people of Rongelap Atoll infer the weather by the direction and strength of the wind and the state of the sky and clouds. Since the influence of radioactivity is widespread and endures for long periods, the duration has resulted in the knowledge coming to lose its usefulness and in the distribution network being broken. Although this is a major damage to the people of Rongelap Atoll, it is a damage that is difficult to assess by the standards of developed countries.

Research investigations on many radiation effects have been conducted so far, and have mainly focused on the influence on individual organism such as animals, soil and plants. The harm to particular societies has not been considered much in these studies.

More important is the damage the people exposed to radiation feel in their real lives.

This approach is criticized from studies based on natural science, as the approach of this paper is not "scientific". The charge is that it is too emotional. In this paper, however, it has been demonstrated that the perceptions and emotions that people have are based on the culture cultivated in their sphere of life. This cannot be elucidated by the natural sciences alone but requires a cultural anthropological approach.

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